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# Leachate Damage Assessment: Case Study of the Peoples Avenue Solid Waste Disposal Site in Rockford, Illinois

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# leachate damage assessment case study of the Peoples Avenue solid waste disposal site in Rockford, Illinois

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# LEACHATE DAMAGE ASSESSMENT

## Case Study of the Peoples Avenue Solid Waste Disposal Site in Rockford, Illinois

This report (SW-517) was written
by KENNETH A. SHUSTER

U.S. ENVIRONMENTAL PROTECTION AGENCY
1976

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## FOREWORD

Since its beginning in 1965, one of the concerns of EPA's Office of Solid Waste Management Programs (OSWMP) has been the development and use of environmentally sound methods of solid waste disposal. OSWMP recognizes that land disposal of wastes is an essential element in any present and future solid waste management system, and it is necessary to ensure that these land disposal sites do not adversely impact the environment. To this end, OSWMP currently has four studies in the area of leachate control: (1) leachate characterization, production, and migration; (2) leachate damage assessment; (3) leachate control technology; and (4) leachate administrative controls (land disposal site permitting and enforcement programs). The goal of these projects is to develop landfill standards or guidelines to protect our surface and ground water resources from leachate contamination.

This report is an output of the leachate damage assessment project. It discusses the leachate damages which occurred at a specific land disposal site.

The leachate damage assessment project examines the impacts and magnitude of the leachate contamination problem in the United States on local, regional, and national levels. This includes the identification of the types and locations of sites causing leachate damages, the types and extent of leachate damages, and the comparison of damage costs and risks to control costs. The leachate damage assessment project establishes the need, if any, for leachate control standards or guidelines, and gives insights into what controls are necessary. This project is described further in Leachate Damage Assessment: An Approach.*

—SHELDON MEYERS
Deputy Assistant Administrator
for Solid Waste Management

*Leachate Damage Assessment: An Approach. Kenneth A. Shuster. Environmental Protection Agency, 1976.

## PREFACE

Leachate is contaminated water which is produced when rain or other water passes through wastes in a land disposal site, picking up various mineral, organic, and other contaminants. Depending on the types of wastes received at the disposal site, leachate may contain various decaying organics, bacteria and viruses, and heavy metals and other toxic chemicals. Unless controlled, each of these contaminants will migrate different distances based primarily on the type of operation, the physical and chemical properties of the contaminants, and the hydrogeologic conditions around the site. If allowed to migrate from the site, leachate may contaminate ground or surface water and result in damages such as polluted wells or fishkills. The occurrence of such damages is directly related to the proximity of the resource to the disposal site, the direction of surface or ground water (leachate) flow, and dilution.

Past disposal practices in the United States have typically overlooked the leachate problem, frequently favoring the use of cheaper and more remote "waste lands" such as flood plains, quarries, sand and gravel pits, and marshlands. These marginal sites tend to be more socially and politically acceptable, as well as cheaper when the leachate problem is ignored.

Due to the lack of ground-water monitoring around disposal sites in the United States, the seriousness and extent of the leachate problem is unknown. In most situations, only when wells are polluted or fish are killed, does the problem surface and attract attention. A number of studies of leachate production and migration at specific sites, however, has been recently completed. Information on leachate migration from damage cases and specific site studies coupled with general information on disposal site locations and operations in the United States indicate that at least one-fourth and possibly as many as three-fourths of the municipal land disposal sites in the United States have leachate migration problems. Hopefully, as more of the older sites are replaced by new sites which are better located, designed, and operated, these conditions will improve.

This report is the first in a series of case studies documenting damages caused by leachate from municipal land disposal sites. Described are the history and type of operation, damages caused by leachate, remedial actions, and associated costs.

The author acknowledges the special assistance of H. Spencer Merz (Superintendent of the City of Rockford Water Department), Tom Cavanagh

and Charles E. Clark (Illinois State Environmental Protection Agency), and Ronald Heinen (Rockford City Engineer) for providing the major information upon which this report is based, and Joyce Corry for editing the report.

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Programs

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## CONCLUSIONS

1. The Rockford Peoples Avenue disposal site was neither located nor operated according to currently accepted sanitary landfill practices. The site was an unlined sand and gravel pit. Wastes were originally placed directly into ground water.

2. The State estimated it would cost between $42,500 and $53,000 to identify the aquifer characteristics and the extent of ground water contamination. Due to this cost and the marginal value of such information in the absence of corrective actions, the testing program was never done. However, due to the proximity of the Rock River (the probable ground water discharge zone), the extent of ground water contamination was probably only about 0.16 to 0.24 square miles.

3. Nine wells were contaminated and abandoned: four industrial wells, one public supply well, and four residential wells.

4. The public supply well and residential wells were to the side and not directly downgradient of the disposal site. But the cone of influence of these wells combined with the cessation of pumping from the four industrial wells altered the ground water flow enough to cause their contamination.

5. Since the public water supply main line was already only several blocks away, it was relatively easy and cheap to replace the industrial and residential wells with public water. The abundance of good ground water in the area meant it was also rather easy and cheap to replace the public supply well.

6. There were no litigations. The industry, the Quaker Oats Company, needed to increase its water capacity. Although the deterioration in the quality of its existing wells was the major factor in the decision to hook up to the public supply rather than dig another well, the Quaker Oats Company paid for hookup to the public supply. The production well and the landfill were both owned by the city of Rockford. The residential wells were replaced by the city when contamination was first reported.

7. Only a partial tabulation of costs was possible due to (1) a lack of information (e.g., man-hours spent on the problem), (2) costs which were difficult to identify or quantify (e.g., water consumption charges, or developmental costs for the new public supply well already incurred), and (3) future impacts on the city's water supply (i.e., the new well was originally

planned for future expansion but became a replacement well instead). A partial cost tabulation, however, was made. The equipment and installation costs to replace the nine wells were $115,500. At least $90,000 more was spent by the various governmental departments and disposal site operator as a result of the ground water contamination problem.

8. No corrective actions were taken except to provide vents for gas escape and a final cover to reduce water infiltration.

9. The damage cost identified in this report ($205,500) covers the basic replacement cost for the contaminated wells (avoidance and administrative costs) and final cover on the site. This cost figure should be considered to be very conservative in that (1) it does not include some of the more difficult costs to identify and quantify, (2) no litigations occurred, (3) a public water supply was nearby, and (4) the contamination was not corrected, just avoided.

## SUMMARY

History. The city of Rockford's Peoples Avenue Landfill was operated from 1947 to 1972 in a former sand and gravel pit in an industrial area within the city limits (Table 1). It received residential, commercial, and industrial wastes from the activities of the city's average population of approximately 125,000 people during this period. No engineering designs were done on the site before the start of operations. The site was unlined, and wastes were initially placed in the ground water.

Damages. Due to the proximity of the Rock River (the probable discharge zone), the extent of ground water contamination was probably only about 0.16 to 0.24 square miles. Nine wells were contaminated and had to be abandoned: four Quaker Oats Company wells, one public supply well, and four residential wells.

Remedial Action. All nine wells were eventually abandoned. In 1966, the Quaker Oats wells were replaced by city water. In 1970, the residential wells were abandoned and city water supplied. In 1970, production from the public supply well was cut back. In 1972, the public supply well was abandoned and another supply well dug in another area of town.

Costs. The initial cost to replace the Quaker Oats wells was about $22,500; the cost to replace the public supply well was about $87,000; the cost to replace the private wells was about $6,000. To increase surface runoff and decrease infiltration, the State Environmental Protection Agency required the city to place a better cover on the landfill which cost about $65,000. These costs totaled $180,500.

These expenditures did nothing to clean up the ground water or to correct the source of contamination. They do not include the value of the many man-hours spent by State EPA, Health Department, Geological Survey, and Water Survey personnel, or the city of Rockford Public Works Department, Engineering, Council, or Water Department personnel in evaluating and administering corrective and avoidance measures. These administrative costs were probably at least $25,000.

TABLE 1

SUMMARY OF THE PEOPLES AVENUE LANDFILL
LEACHATE DAMAGE CASE

| | |
|---|---|
| Type of operation | open dump, landfill incinerator residue |
| Location | sand and gravel pit |
| Years of operation | 1947-1972 |
| Types of wastes | residential, commercial, industrial |
| Size of operation | |
| Acres | 40 (16 ha) |
| Peak annual tonnage | 95,000 (85,500 t) |
| Waste thickness (ft) | 55 (16.8 m) |
| Annual precipitation (in./year) | 37 (94 cm) |
| Extent of contamination | 0.16 to 0.24 $mi^2$ (0.41 to 0.62 $km^2$) |
| Damages | 4 residential wells<br>4 industrial wells<br>1 public supply well |
| Remedial actions | all wells abandoned; public water supplied; new public supply well; regrading and covering of landfill surface |
| Litigation | none |
| Costs | |
| Value of damaged resources (wells) | $ 94,800 |
| Damage costs (e.g., clothes, fixtures) | 0 |
| Corrective costs | 65,000 |
| Avoidance costs | 115,500 |
| Administrative costs | 25,000 |
| Total costs (excluding value of wells) | $205,500 |
| Status | Concluded |

## HISTORY OF SITE DEVELOPMENT

Location. The city of Rockford is located in northern Illinois, 17 miles south of Wisconsin and 85 miles northwest of Chicago. The Peoples Avenue Landfill is situated in an industrial park within the city limits, in southern Rockford. The landfill is about 700 to 800 feet east of the Rock River (Figure 1). Between the landfill and the Rock River is a Quaker Oats Company, Pet Foods Division, production plant which had four wells on the site. On the landfill property was public supply well No. 14 belonging to the city of Rockford's Water Department. To the south was a low income residential area using individual domestic wells.

History and Type of Operation. The Peoples Avenue Landfill was formerly a sand and gravel pit. In 1947, the city of Rockford purchased the site for waste disposal. Private haulers may have started using the site for waste disposal about one or two years earlier, but no waste went into the site prior to 1945 (Figure 2). The city owned the site but contracted private firms to operate it. Several different operators had the contract over the years. In 1951, an additional part of the sandpit was purchased by the city. Sand was removed from most of the 40-acre site, about 30 to 40 feet below grade. The water table was about 34 feet below grade as evidenced by a pond of water in the eastern section of the disposal site. Waste was initially placed in and close to the ground water. By 1958, the large waterhole had been filled with waste and covered with soil (Figure 3).

From about the mid-1950s to 1968, a small incinerator on the site processed some of the waste to reduce its volume. It is unknown how frequently cover material was used before 1960, but apparently the site was operated as an open dump and infrequently covered until the mid-1950s. From some time between 1960 and 1965 through 1972, the site was operated with daily soil cover. In 1970-71, the cover material included substantial fly ash and foundry sand. On July 17, 1972, the site was officially closed, about 15 to 30 feet above grade. On July 18, 1972, the first loads of waste were delivered to the new Rockford Blacktop Company's asphalt-lined landfill, located in a 75-acre sand and gravel pit about 5 miles south of Rockford, called Pagel's pit.

Types and Amounts of Waste Disposed. The Peoples Avenue Landfill received residential, commercial, and industrial wastes throughout its life. Since Rockford is the world's largest manufacturer of screws and second largest tool manufacturer, industrial wastes included metals finishing and foundry wastes. Some data on waste amounts were obtained. In 1949, a recorded 95,232 cubic yards of waste went into the disposal site. Using 450

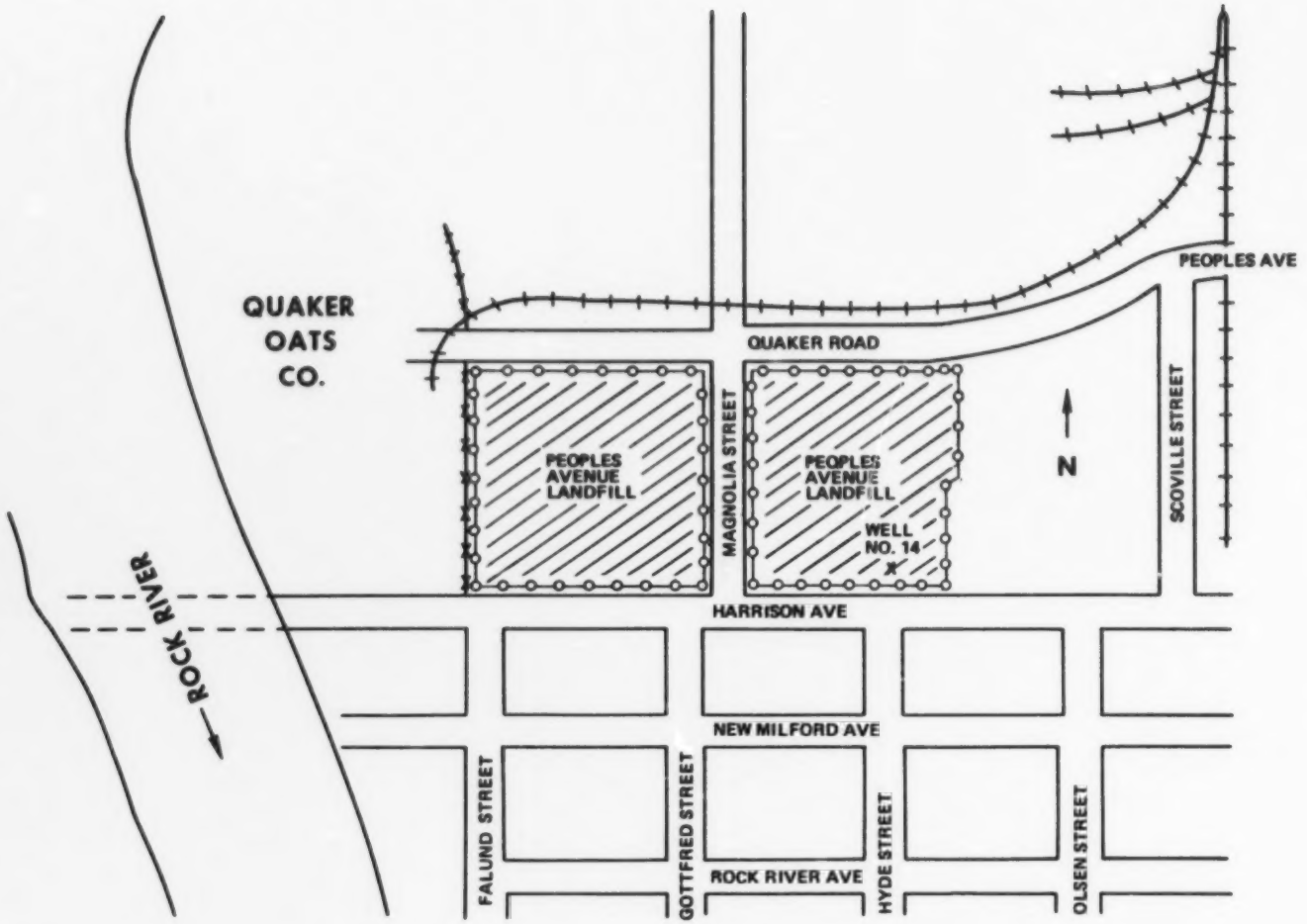



**Figure 1.** This map shows the location of the Peoples Avenue Landfill, Rockford, Illinois.

**Figure 2. This photograph shows the Peoples Avenue Landfill site (Sahlstrom sand and gravel pit) about 1945.**

**Figure 3. This photograph shows the Peoples Avenue Landfill, Rockford Illinois, in summer 1958. The waterhole has been filled in and covered.**

pounds per cubic yard, this amounts to about 21,400 tons in 1949 (about 1.29 lbs per capita per day). At one point, 70,000 chickens were placed in the landfill. In 1968, the two-can limit was changed to unlimited residential pickup which resulted in a jump in waste volume. In 1971, about 38,950 tons of "household" waste went into the landfill (about 1.43 lbs per capita per day). In 1972, this increased by 30 percent to about 50,160 tons (about 1.83 lbs per capita per day) because of a no-burning ordinance which became effective in April 1972, and which resulted in increased newspapers, leaves, and other combustibles. In the first six months of 1973, 25,910 tons of "household" waste were collected (about 1.88 lbs per capita per day).

Topographical maps of the site in 1956, 1965, 1971, and 1974 show that the bulk of the volume of waste was placed in the disposal site after 1965. However, this may also be indicative of the volume taken up by daily cover material. Using 3.5 lbs per capita per day total waste for 1971, the landfill received a peak annual tonnage of about 95,000 tons. In early 1971, the site reached grade; by the end of 1971, half of the site was about 400 feet above grade and the other half (closest to the Quaker Oats Company) was about 10 feet above grade.

Site Selection and Engineering Design. The site was a sandpit. There are no evidences of design work on the landfill, although the topographic charts of the site showing the filled-in areas do indicate some planning for the site.

When the ground water pollution and migrating gas problems arose, a landfill stabilization, leachate and gas control, and final use plan was developed. However, due to costs, this plan was never implemented. Only the installation of gas vents and final grading were accomplished.

Hydrogeological Description of Site. The Peoples Avenue Landfill is in an old sand and gravel pit, dug about 30 to 40 feet below grade. The site is basically sandy glacial till. Although about 1/4 mile from the Rock River, the site is not in the flood plain. For approximately the first three years, waste was placed in ground water in at least the eastern part of the site.

The natural ground water flow under the landfill is toward and perpendicular to the Rock River. The Quaker Oats Company wells were in this path.

Climatological data show Rockford has hot humid summers and cold winters. The relative humidity rarely drops below 50 percent, usually ranging from 55 to 80 percent. The average annual precipitation during the life of the landfill (1947 to 1973) was 36.8 inches with the low year of 24.3 inches

and the high of 56.5 inches. During this period, the low month had 0.01 inch and the high had 11.8 inches. These data indicate a high net infiltration and leachate generation potential at the site, even if the wastes had not been placed in the ground water.

## LEACHATE DAMAGE ASSESSMENT

Since no monitoring program was ever established for the Peoples Avenue Landfill, the extent of leachate contamination of the ground water was never determined. However, using the location of contaminated wells as indicators, and assuming that the ground water is contaminated beneath the landfill all the way downgradient to the Rock River, the probable discharge zone, at least 65 acres and most likely 100 to 150 acres (or 0.16 to 0.24 square miles) were contaminated.

There were three types of wells affected by the Peoples Avenue Landfill: Quaker Oats Company production wells, City of Rockford public supply well No. 14, and private residential wells.

### Quaker Oats Company

Problem Identification. The Quaker Oats Company had four wells on its property which served as its sole water source prior to 1966 (Table 2). In 1965, the plant experienced a degradation in the taste and odor of its water. At the same time, a drop in the capacity of the wells was experienced. The main source of water was well No. 4 which dropped to about 700 to 1000 gpm in 1965.

TABLE 2

QUAKER OATS COMPANY WELLS

| Well no. | Date drilled | Elevation (ft) | Depth (ft) | Capacity (gpm) | Usage 7-25-63 (gpm) | Date discontinued use |
|---|---|---|---|---|---|---|
| 1* | 1907 | 710 | 308 | --- | 0 | 1953 |
| 2* | 1907 | 702 | 300 | 400 | 400 | 1966† |
| 3 | 1929 | 738 | 450 | 600 | 500 | 1966† |
| 4‡ | 1953 | 732 | 240 | 2,000 | 1000-1400 | 1966† |

*Located in Rock River flood plain.
†When hooked up to city water supply.
‡Well closest to the landfill.

Leachate Characterization. Only four chemical analyses on samples from the Quaker Oats wells were located, although the wells were reportedly constantly sampled (Table 3). The well samples showed high total dissolved solids and relatively high iron. A letter dated November 16, 1954 indicates that coliform bacteria were found in wells No. 2 and No. 3 and that the possible sources of pollution, in order of probability were: (1) from the surface directly, (2) from the "new city garbage dump," or (3) from the surface through defective casings.

TABLE 3

QUAKER OATS COMPANY WATER ANALYSIS

| Chemical | 4-22-53 * mg/l | 11-9-56 * mg/l | 7-25-63 Well No. 4 mg/l | 7-25-63 Well No. 3 mg/l |
|---|---|---|---|---|
| Chloride (Cl) | 33.5 | 48.0 | 28 | 35 |
| Iron (Fe) | 0.3 | 0.1 | --- | --- |
| Fluoride (F) | 0 | --- | --- | --- |
| Nitrate ($NO_3$) | --- | 20.0 | --- | --- |
| Sulfate ($SO_4$) | 134.5 | --- | --- | --- |
| Silica ($SiO_2$) | 12.0 | --- | --- | --- |
| pH | 8.2 | --- | --- | --- |
| Total hardness (as $CaCO_3$) | 416.0 | 446.0 | --- | --- |
| Total dissolved solids | 616† | --- | 458 | 568† |

*Samples taken from Quaker Oats Company, thought to be well No. 4.
†Exceed 1962 PHS or 1972 EPA drinking water limits.

Damages. The well water degradation as evidenced by offensive taste and odors, forced the Quaker Oats Company to abandon their wells and go to city-supplied water. No equipment or products were damaged by contaminated water. A methane gas problem also developed at the Quaker Oats plant as a result of waste decomposition in the disposal site (Appendix B).

Remedial Action. Because of the deterioration in water quality, the decrease in well capacities, the increase in water needed for fire protection, and plant expansion plans, Quaker Oats Company conducted an in-house study in which it concluded that the Company should switch to city water rather than dig another well and risk contamination or low capacity. On July 1, 1966 the Quaker Oats Company was hooked up to city water and discontinued use of its wells.

## Public Supply Well No. 14

Problem Identification. One of the city of Rockford's water supply wells, well No. 14, is located on the southeast corner of the landfill property, near the landfill itself. The well was drilled in 1957, 10 years after the landfill was started (Table 4). It is 235 feet deep and has a deep well turbine which discharged to a small 30,000 gallon reservoir. Two booster pumps pumped from the reservoir to the distribution system.

In 1968 or 1969, it was found that the water was acceptable when one pump was used; but when both pumps were used, the increase in contaminants was too great, and undesirable odors and taste developed.

TABLE 4

CITY OF ROCKFORD PUBLIC SUPPLY WELL NO. 14

| Date drilled | Depth (ft) | Usage (gpm) | Date discontinued use |
|---|---|---|---|
| August 1957 | 235 | 2,800* | 1970 |

*Recorded May 1, 1970.

Leachate Characterization. The results of six chemical analyses on water from well No. 14 were obtained (Table 5). Significant increases in chlorides, manganese, sodium, ammonia, alkalinity, hardness, and dissolved minerals occurred over the years. Calcium and magnesium also increased. Relatively unchanged were iron, fluoride, nitrate, and sulfate. Exceeding the 1962 PHS or 1972 EPA drinking water standards were iron, manganese, ammonia, dissolved minerals, and odor. Figure 4 shows the deterioration of water quality over the years in well No. 14.

## TABLE 5

### CITY OF ROCKFORD PUBLIC SUPPLY WELL NO. 14 WATER ANALYSES

| Chemical | 1972 EPA limits mg/l | 8/7/57* mg/l | 8/27/58 mg/l | 9/16/59 mg/l | 10/9/63 mg/l | 4/22/70 mg/l | 2/22/73 mg/l |
|---|---|---|---|---|---|---|---|
| Chloride (Cl) | 250 | 24 | 13 | 15 | 30 | 135 | 165 |
| Iron (Fe) | 0.3 | 0.3 | 1.7† | 1.3† | 0.9† | 0.7† | 1.8† |
| Manganese (Mn) | 0.05 | 0.1† | 0.2† | 0.4† | 0.42† | 0.7† | 0.71 |
| Calcium (Ca) | -- | -- | 97.5 | 90 | -- | 100 | 130 |
| Magnesium (Mg) | -- | -- | 40.8 | 39 | -- | 45 | 53 |
| Sodium (Na) | -- | -- | 5 | 6 | -- | 100 | 110 |
| Fluoride (F) | 2.2 | 0.2 | 0.0 | 0.2 | -- | 0.2 | 0.2 |
| Boron (B) | -- | -- | 0.0 | -- | -- | -- | -- |
| Lead (Pb) | 0.05 | -- | -- | -- | -- | -- | 0.0 |
| Potassium (K) | -- | -- | -- | -- | -- | 25 | -- |
| Nitrate ($NO_3$) | 45 | 1.2 | 0.4 | 0 | 5.7 | 0.4 | 0 |
| Sulfate ($SO_4$) | 250 | -- | 57.0 | 60 | -- | 52 | 62 |
| Silica ($SiO_2$) | -- | -- | 17.4 | 4.5 | -- | 25.4 | 13 |
| pH | 5.0-9.0 | -- | -- | 7.3 | -- | 7.3 | 7.7 |
| Alkalinity (as $CaCO_3$) | -- | 352 | 344 | 314 | 352 | 455 | 550 |
| Total hardness (as $CaCO_3$) | -- | 248 | 412 | 385 | 432 | 484 | -- |
| Specific conductance ‡ | -- | -- | -- | -- | -- | 1330 | -- |
| Residual | 500 § | -- | -- | 410 | -- | -- | 663† |
| Total dissolved solids | 500 § | 476 | 457 | 420 | 525 | 800† | -- |
| Turbidity | -- | 10 | 10 | -- | 5 | -- | -- |
| Color | -- | 0 | 0 | -- | 0 | -- | -- |
| Odor | free | 0 | 0 | -- | $H_2S$ at well† | -- | -- |
| Temperature (°F) | -- | -- | 54.5 | -- | 52.5 | -- | -- |

*Date well drilled

†Exceed drinking water limits. Of the 1972 EPA drinking water limits, only Pb, F, and $NO_3$ are of concern with respect to health; the others are of concern with respect to taste (aesthetics). None of the constituents of health concern exceeded the limits.

‡ Micromhos/cm

§ 1962 PHS limits

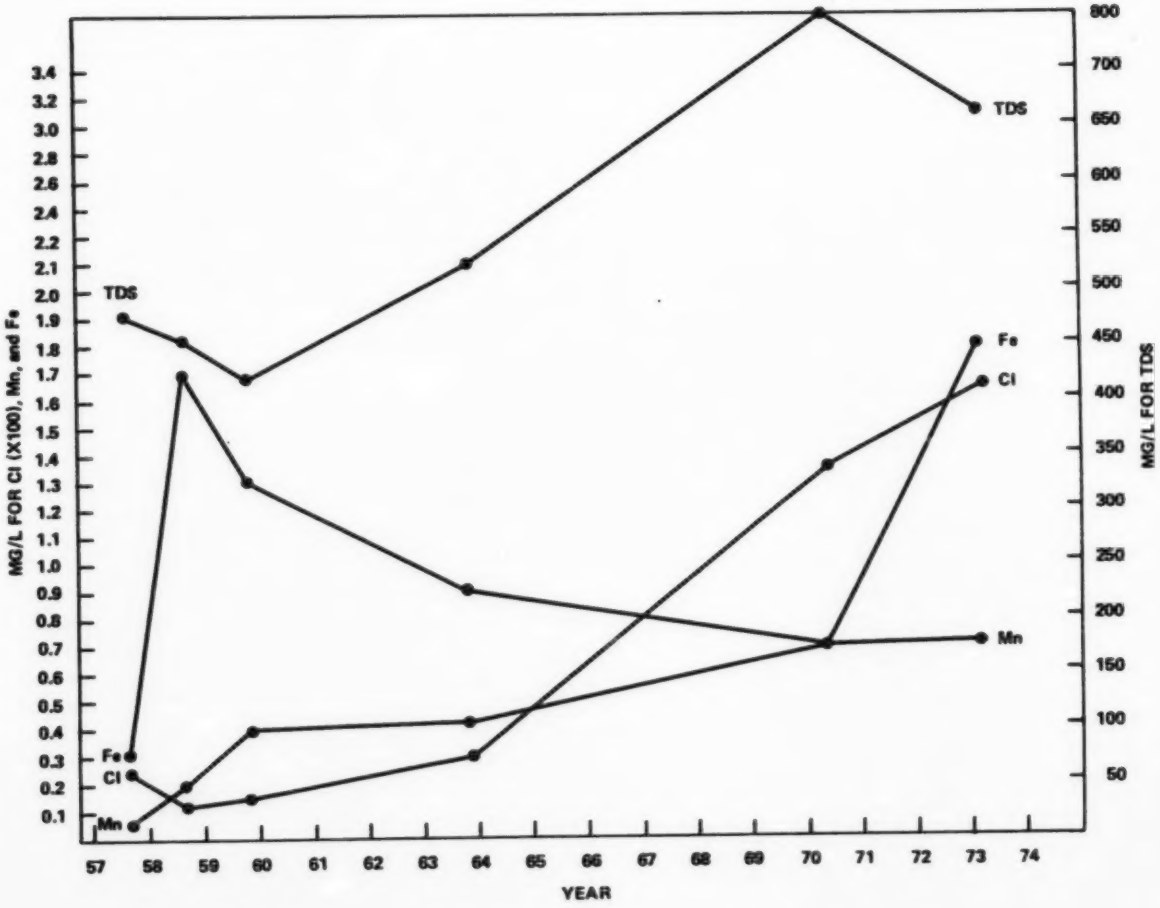



**Figure 4. Chemical analyses of Public Supply Well No. 14 near Peoples Avenue Landfill showing deterioration in water quality over the years.**

A water sample was also collected from well No. 14 on January 22, 1964 for gas analysis (Table 6). A small amount of methane was detected. Since methane would not normally be a constituent of water in the drift formations in Rockford, it indicates migration of the products of decomposition in the landfill to the well.

TABLE 6

CITY OF ROCKFORD WELL NO. 14 WATER ANALYSIS*

| Gas | Composition (%) | Free gas (cu ft/1000 gal) |
|---|---|---|
| $CO_2$ | 44.1 | |
| $H_2$ | 0.0 | |
| $CH_4$ | 1.4 | 0.1 |
| $N_2$ | 47.5 | 3.8 |
| Air† | 7.0 | 0.6 |
| Total | 100‡ | 4.5 |

*Water sample taken 1-22-64
†Air 20.9% $O_2$, 79.1% $N_2$
‡230 cc

Damages. Due to contamination, well No. 14 ultimately had to be abandoned.

Remedial Action. Due to the increased chemical contaminants and undesirable taste and odor, production was first cut back by using only one pump. In late 1970, well No. 14 was removed from regular service. In 1972, it was permanently removed from service.

Well No. 35, originally planned for expansion of the city's water system, was drilled soon after well No. 14 was shut down to help alleviate the effects of its loss and meet the growing demands for water in Rockford. Well No. 38 followed soon thereafter. Currently, there are 41 or 42 wells in the system.

## Private Residential Wells

Problem Identification. South of the landfill, across Harrison Avenue, was a low-income residential area. In 1969, well water in this area became discolored, brackish, and distasteful.

Leachate Characterization. No well sample analyses on these wells were located.

Damages. Four shallow domestic wells were contaminated (two on Hyde Street, one on New Milford Avenue, and one on Harrison Avenue).

Remedial Action. Without admitting the disposal site was the source of contamination, the city brought in waterlines from the mainline on Harrison Avenue to furnish water to the affected homes, and sealed off the contaminated wells. These homes are in an urban renewal area and there are no families living in the area today, with the former homes either vacated or demolished.

## LEACHATE DAMAGE COSTS

Avoidance Costs. Avoidance costs are those costs incurred to avoid contaminated water by using another water source. All the contaminated wells were abandoned and the polluted ground water avoided. The four Quaker Oats Company wells were replaced by piped-in city water. The public supply well No. 14 was ultimately shut down and a new public supply well was constructed. The four residential wells were sealed and city water was piped in. The following avoidance costs were incurred.

Quaker Oats Company. There were three types of costs incurred by the Quaker Oats Company as a result of the contamination of their wells: (1) administrative and study costs, (2) costs of pipes and hookup to the city water supply, (3) the annual cost of city water over the cost of pumping well water.

No consulting/engineering fees were incurred by Quaker Oats since the evaluation between alternatives (dig new wells or go to city water) was done in-house. The cost of monitoring of the wells (sampling and analysis) was borne by an in-house lab (minimal cost) and by Illinois State labs. Some administrative costs were incurred to oversee the transition from wells to city water. Available correspondence shows that several meetings of the Quaker Oats personnel with the city (Public Works Department and Water superintendent) and with the State (Geological and Water Surveys and Health Department) occurred. These meetings involved discussions of water analyses, alternatives to the contaminated well problem, hooking up city water, and resolving the migrating methane gas problem through landfill stabilization and venting programs. It is estimated the Quaker Oats plant engineer, management, and staff spent about three man-months on these administrative and study activities. Assuming a $30,000 per year salary, fringe benefits, and overhead cost, this amounts to an estimated $7,500.

On August 31, 1965, Quaker Oats paid $6,466.80 for a 16-inch mainline down Harrison Avenue to plant property, and about $200 and $300 for a 6-inch and an 8-inch line from the main to the property line. Quaker Oats then extended the line to their plant for an additional $8,000 for a total cost of about $15,000.

The annual cost of water used runs about $20 to 25,000 per year, whereas previously the cost of water was only the cost of pumping it.

Positive effects from the city water supply hookup were reduced costs for fire protection (with the plant expansion, another water tower would have been required) and fire insurance.

Since there was no temporary water used, no equipment or products lost, or even any lost production time, there were no associated costs. Neither were there any litigation costs.

Public Supply Well No. 14. Well No. 35, which essentially replaced well No. 14, was located in another part of the city. It was drilled 210 feet deep and cased down to 150 feet below grade. The total cost of well No. 35 was about $75,000 (Table 7). It was located on city park land which avoided land cost. Otherwise, the average cost of land for a well is $1,000 to $5,000. The maximum the Water Department will pay for land is $5,000. All sites recently have been put on public lands such as park land or school property.

TABLE 7

COSTS OF WELL NO. 35

| Item | Approximate costs |
|---|---|
| Well drilling, casing, and test hole | $25,000 |
| Pump house | 25,000 |
| Pumps, piping, electrical switch gear | 25,000 |
| Total | $75,000 |

Private Residential Wells. On September 9, 1970 the city of Rockford paid $4,934.40 to the Water Department for a 6-inch cast iron pipe laid approximately two blocks from Harrison Avenue to the four affected homes. The homes paid for the 3/4-inch hookup pipes from street to house ($76.80 per home) and water meters ($26.00 per meter). Any plumbing expenses were in addition to these costs.

Corrective Costs. Corrective costs are those costs incurred to remove the source of contamination or clean up or control contaminated ground water such that the resource may be utilized again. In 1971 and 1972 a landfill stabilization and corrective program was developed by the State and city. The State Geological and Water Surveys proposed a ground water (leachate) counter-pumping and recirculation program to hasten landfill stabilization and to confine the contaminated area. A gas-venting program and water- and gas-monitoring programs were also proposed. These programs were to be operated for at least 10 years. The estimated initial costs for monitoring and aquifer test wells, and instrumentation were $42,500 to $53,500. It was determined that to dig up and remove the landfill was economically and physically unrealistic.

Ultimately, these corrective programs were not implemented. The State EPA, however, required the city of Rockford to provide suitable final cover and regrade the site. It was recognized that this regrading program would not correct the problem, but would reduce rainwater infiltration. In the fall of 1974, this program was implemented, costing $50,000 for fill and about $15,000 for grading and seeding.

Administrative Costs. No estimates on administrative expenses were obtained. However, it can be assumed that the city of Rockford Public Works and Water Department spent at least six man-months, and the State Geological Survey, Water Survey, Health Department, and Environmental Protection Agency spent at least six man-months for administrative costs. Assuming $25,000 per year per professional for salary, fringe benefits, and overhead, administrative costs amounted to at least $25,000. This amount does not include expenses for travel, per diem, taking water samples, or locating and developing a public supply well; neither does it include some expenses associated with developing, evaluating, and implementing avoidance and corrective alternatives, or attending meetings.

Litigation. There were no legal actions taken by any of the damaged-well owners.

## CURRENT STATUS

The Peoples Avenue Landfill was officially closed in July 1972 and has since been graded and seeded. The city of Rockford wastes are currently going to a State-permitted asphalt-lined landfill located in a sand and gravel pit about five miles south of Rockford. All the contaminated wells were replaced with public water. No attempts were made or are planned to retrofit the landfill or correct the ground water contamination problem. No litigation is pending.

After 10 years, the Water Department returns the main-line costs paid, having recovered the cost by the interest on the money held for the 10-year period. Thus, in 1976, Quaker Oats Company will get its $6,466.80 back, and in 1980, the City will get its $4,934.40 back.

## SOURCES


1. Personal communication. T. Cavanagh, formerly Deputy Public Works Commissioner, City of Rockford, currently with State of Illinois Environmental Protection Agency, to K. A. Shuster, Office of Solid Waste Management Programs, Feb. 11, 1975.

2. Personal communication. H. S. Merz, Superintendent, City of Rockford Water Department, to K. A. Shuster, Office of Solid Waste Management Programs, Feb. 1975.

3. Personal communication. R. Heinen, Rockford City Engineer, to K. A. Shuster, Office of Solid Waste Management Programs, Feb. 13, 1975.

4. Personal communication. J. Smith, Acting Plant Manager, Quaker Oats Company, to K. A. Shuster, Office of Solid Waste Management Programs Feb. 13, 1975.

5. It's time to talk about trash. Rockford Register-Republic, 109(98):12-June 10, 1963.

6. ACT Systems, Inc. Residential collection systems; final report. v.3. Annexes. U.S. Environmental Protection Agency, 1974. 1 v. (various pagings). [Open-file report; restricted distribution.]

7. Various letters and reports by C. Clark, State of Illinois Environmental Protection Agency; G. Hughes, Illinois State Geological Survey; R. Schicht, Illinois State Water Survey; and the Franz Lipp-Marvin Wehler Partnership; Aug. 1971-June 1972.

## APPENDIX A

# Well Information for Layne-Western Co.

This sheet is to be filled in and mailed to office upon completion of well

1. C-165, City of Rockford, Ill. (Name of Job) Aug. 7, 1957 (Date)
2. Rockford (City) Ill. (State)
3. Well No. 14 Vogt (Driller's Name)
4. Well location: In City dump on Harrison St.
   Give Distance and Direction from Permanent Land Mark so Well can be Accurately Located Several Years from now.
5. Work began July 9; work completed Aug. 7 Number of working days 27
6. Diameter, length and type of material left in well:
7. 80 feet of shutter (Shutter, Concrete, Keystone) screen made of stainless steel (Armco, Bronze, Stainless Steel, Concrete) No. 5 (Mesh) openings.
8. 10 feet of 16 inch inside casing made of stainless steel (Armco, Std. Pipe, Concrete) with welded (Riveted, Welded, Screw) connections.
9. 161 feet of 20 inch outside casing made of cast iron (Armco, Std. Pipe) with screw (Riveted, Welded, Screw) connections
10. 60 yards of gravel used in well. Size pea gravel (see record below)
11. Test of well. Did you use test or permanent pump? test 12" SFLC (Size of Bowl) 4 (Stages)
12. Pump No. 8 x 11 geared head No. ....; ratio 1:1; r.p.m. ....; pulley diam. ....
13. Power used Ford (Electric Motor, Engine) horse power 125; voltage ....; r.p.m ....; pulley diam. ....; r.p.m. ....
14. Size of orifice 8 inch, by 10 inch. Orifice tube reading .... inches.
15. Pumping test—measurements from ground level:

| Time | G.P.M. | Static | Drawdown | Pumping Level |
|---|---|---|---|---|
| 6½ hrs. | 1879 | 43' | 23' | 50' |
| Gravel placed a follows: | | | | |
| 225 - 235 | pea gravel and torpedo sand | | 75' to 75.' | |
| 225 - 210 | " " | | | |
| 210 - 200 | " " and torpedo sand | | 75.' to 75.' | |
| 200 - 190 | " " | | | |
| 190 - 185 | " " and torpedo sand | | 75.' to 75.' | |
| 185 - 179 | " " | | | |
| 179 - 145 | " " and torpedo sand | | 75.' to 75.' | |
| 145 - 118 | Torpedo sand | | | |
| | | | | |

16. Recovery in 5 minutes ...., in 30 minutes ....
17. Customer's pump No. .... was installed in this well by ....

18. Did you seal bottom of well? Yes Thickness 3/8 inches, material [illegible]

19. Was well under-reamed? No From ____ feet to ____ feet.
From ____ feet to ____ feet.
From ____ feet to ____ feet.

20. If all screen was not placed at bottom, state how it was spaced.
From ____ feet to ____ feet; from ____ feet to ____ feet; from ____ feet to ____ feet.

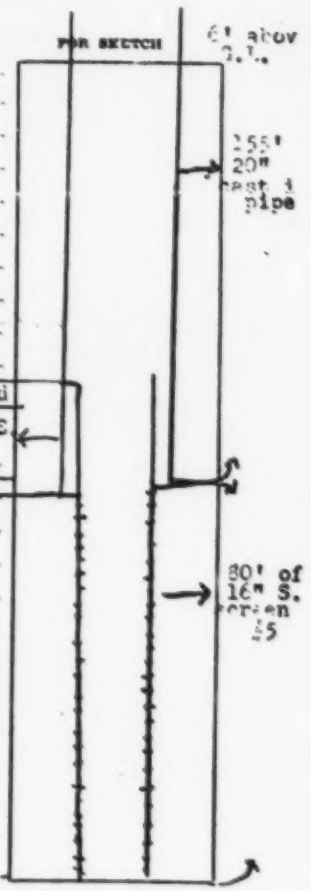
21. Depth of well (from ground level to top of plug) 235 feet ____ inches.

22. Was cement placed around or between any of the casings? ____

23. If, so, state where, how much and method used. 115' to ground level, 46 yards ready mix, through gravel pipe

24. Log of well from ground level:

| Feet | | Feet | Formation |
|---|---|---|---|
| 0 | to | 1 | Fill |
| 1 | to | 31 | Loose fine sand and gravel |
| 31 | to | 84 | " " " and coarse gravel |
| 84 | to | 93 | Clay few sand streaks |
| 93 | to | 110 | Coarse sand and fine sand streak |
| 110 | to | 115 | Coarse sand |
| 115 | to | 118 | Yellow clay |
| 118 | to | 148 | Grey clay (jointed) |
| 148 | to | 160 | Fine sand |
| 160 | to | 175 | Med. fine sand |
| 175 | to | 185 | Med. coarse sand, trace of fine gravel |
| 185 | to | 190 | Med. sand |
| 190 | to | 200 | Med. coarse sand |
| 200 | to | 210 | Fine sand, trace of gravel |
| 210 | to | 225 | Coarse sand and gravel |
| 225 | to | 235 | Coarse sand and gravel, some fine silty brown sand |
| ____ | to | ____ | |
| ____ | to | ____ | |
| ____ | to | ____ | |
| ____ | to | ____ | |




25. Remarks:



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## APPENDIX B

### Methane Gas Problem at the Quaker Oats Plant

A methane gas problem created by the landfill developed in the basement of the Quaker Oats Company plant bakery. Upon ignition, gas would burn from cracks in the concrete floor of this building. On April 14, 1967, a sample of gas was collected from a 2-foot diameter manhole (dry well No. 2) in the basement of the bakery section of the plant (735-feet elevation). This well had been about 6-feet deep with a sand bottom, but was later filled with sand. A 6-foot section of the 1/2-inch pipe with the lower 1-1/2 feet perforated with 1/8-inch holes was driven to the bottom. The gas sample was collected at the top of the pipe. The gas chromatograph showed a high level of methane (Table B1). To enable a comparison, and to check the methane source, a 12-foot deep hole (741-feet elevation) with 3-inch casing was drilled in the landfill about 180 feet and across a road from the Quaker Oats manhole, and a gas sample was taken (Table B1). This sample showed even higher methane gas concentration. When the top of the pipe was ignited, a 1- to 2-foot flame resulted. No explosions or fire damages resulted from methane concentrations at the Quaker Oats plant. Evidently, venting pipes were placed through the landfill and corrected the problem.

TABLE B1

GAS CHROMATOGRAPHY ANALYSIS TO DETERMINE
METHANE LEVELS, APRIL 14, 1967

| Gas | Quaker Oats Company Manhole No. 2 basement of bakery plant | City landfill property gas vent well |
|---|---|---|
| $CO_2$ | 32.8% | 36.1% |
| $O_2$ | 0.7% | 0.1% |
| $N_2$ | 27.2% | 0.4% |
| Methane | 39.3% | 63.4% |
| Total | 100.0% | 100.0% |
| BTU/$ft^3$ at 760 mm, 60°F | | |
| Gross | 398 | 642 |
| Net | 358 | 578 |
| Specific gravity | | |
| Calculated | 0.98 | 0.90 |
| Determined | 0.95 | 0.85 |

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